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AVIATION AND AERONAUTICAL ENGINEERING



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VOLUME VI
Number 12

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Vol. VI

July 15, 1935

No. 15

THE 3,500-mile voyage of the British ship R-34 from Scotland to the United States, accomplished in the face of strong head winds and violent atmospheric disturbances, is an event comparable in its significance with the first crossing of the Atlantic by a steamship, just one hundred years ago.

Considering that the prevailing winds in the North on Atlantic flow from the western quarter, aircraft passages from Europe will always be handicapped by head winds and take more time than outward trips. This is who all but one of the British transatlantic airplanes were scheduled to start from Newfoundland, so as to secure acceleration from following winds. Therefore the epoch-making voyage of the R-34 is not only a brilliant exhibition of lighter-than-air craft with regard to their ability to cover great distances without alighting, it also proves that winds can successfully overcome the most severe weather conditions and reach their destination despite delays due to head winds. That these delays are fatal to airplanes and seaplanes, particularly in coast flights, is the opinion of the first visitor of the Atlantic, Commander Hood, who pronounced the flight of the R-34 the most important of three successful Atlantic flights.

This voyage is the more remarkable if it is considered that it was undertaken without previous knowledge of the atmospheric conditions which prevail over the Atlantic, the expansion of the R-34 will therefore prove of considerable value to meteorological experts and serve as a working basis upon which the charting of the oceanic atmosphere may be begun. Such work would be of the utmost importance for the future of oceanic air navigation and should be, if possible, promptly undertaken. By the nature of the voyage in it, then, in the United States Great Britain and France, which being separated by the Atlantic, would benefit the most by having it opened by swift and safe aerial services.

The first transatlantic flight by lighter-than-air craft and the first aerial passage in the westward thus assumes the importance of a true pioneer achievement which will immortalize the names of Major Scott and his crew and further strengthen the bonds of friendship between Great Britain and the United States.

Armament and Accessories

Prior to the War and in the initial stages of the War, the airplane was a simple machine equipped with an engine, a propeller, engine controls and pilot controls, seating arrangements for a passenger and pilot. An

altimeter and an air speed indicator were sometimes carried.

Now we find the airplane carrying an enormous amount of equipment. For navigational purposes, compasses, altimeters, air speed indicators, drift indicators, heading and longitudinal instruments are almost invariably carried. Oxygen tanks have to be provided for altitude purposes.

Parachutes will soon certainly be required in the near future.

Armament on a military machine involves a whole design in itself. Lights, communication boxes, turrets, fenders, ejectors, have to be provided. In a military machine, it is no longer a question of designing an airplane pure and simple, it is a question of designing a machine round the equipment and armament to be carried.

No designer can afford to neglect this point of view in the initial stages of his work.

Municipal Airports

The lead taken by the city of Albany, N. Y., with the establishment of the first municipal airfield in the United States, may soon be followed by New York City, whose Board of Estimate is discussing the advisability of creating a municipal landing station for aircraft.

No scheme could be more timely in view of the rapid development of aircraft. Although there are several excellent landing fields in the neighborhood of New York, the need for a municipal airfield, so located as to be easily and quickly accessible from any borough of the great metropolis is obvious, for such an arrangement would greatly reduce the loss of time incurred in traveling to and from the present landing fields. The Post Office Department fully realized this when it moved its aerial mail terminal from Belmont Park to Newark, N. J., whence the Hudson tube greatly shortens delivery of the airborne mail.

A point worth consideration in the planning of a municipal airfield for New York is that it should be of great proportions, or at least be capable of considerable expansion, as ample facilities will be available for future increases of aerial traffic.

At the same time since provision should be made for receiving a certain size in New York harbor as a seaplane landing station, this would prove very useful to pilots engaged in coastwise flying, provided the station is free from obstructions and has sufficient fringing for taking off.

Altitude Errors in Aerial Navigation

A New Form of Barograph for Their Avoidance

By J. G. Coffin

Assistant Director of Research, Cessna Engineering Corp.

All flying machines and navigators are at present provided with some form of barometer, either automatic or not, for ascertaining altitudes. These instruments are usually of the aneroid type and their indications are supposed to give the altitude of the machine during its flight. Their indications are generally taken for granted as being accurate after allowance has been made for ground level and for temperature are made. The altitude is none the less of the static air pressure at the point where altitude is desired. The exact relation between height and static pressure can be expressed by a well known formula and corrected for temperature. For the formula and corrections to be applied reference is made to

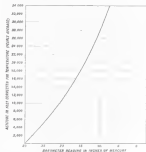


FIG. 1. ALTITUDE-PRESSURE CHART CORRECTED FOR STANDARD TEMPERATURES

the Smithsonian meteorological tables. It is better and more reliable, however, to use the results of the extensive observations carried on in various countries with sounding balloons. A graph showing the most probable relation between the barometric reading and altitude can be given and is to be preferred to the formula.

The actual altitude of a machine on, of course, be obtained by ground observations with surveying instruments but this method is evidently a complex one, is resorted to in a given locality and requires several observers and considerable expenditures. It is for practical reasons out of the question. The practical requirements reduce themselves then to that of obtaining the true static pressure during the flight, the transformation of these pressures to corresponding altitudes being taken care of as above described.

It is shall assume that the instrument is a perfect one, correctly measuring the pressure acting on it, so as to bring and show clearly other errors of its use as contemplated here. The great objection here referred to is the use of existing instruments and that they do not record the pressure at the air in a given region acting on them but that this pressure is not the true static pressure, there being an error which is a function of the speed of the machine, the position of the instrument as to the machine and the air density. This error is so great as to make

the speed of the machine, the position of the instrument as to the machine and the air density. This error is so great as to make highly. For example, at a speed of 60 m.p.h., which today is not over the usual landing speed of a fast machine, the error may amount to over 200 ft., and at 100 m.p.h., a common air speed at the present time, it may be over 1,000 ft. For a pilot flying on a base or in clouds it is of prime importance that he know his height above the ground fairly well, and this, these figures, for he may think himself flying well up and may be actually in dangerous proximity to the ground and liable to a serious accident.

The barometer is usually enclosed in a box or case but this case must have an opening to the external air so as to permit of the communication of the atmospheric air pressure to the instrument. If the box is airtight except for a single opening, for example, that aperture may be directly facing the air stream, in which case the pressure within the box and, consequently, registered in the instrument is static pressure plus the aerodynamic pressure corresponding to the speed of the air at that point. If the opening is on the side it may have a "vena contracta" effect and the error may be much more, but also



FIG. 2. DISTRIBUTION OF PRESSURE AROUND A STREAMLINE IN A CORNER OF AIR

various other large distortions. If the opening is at the rear, the instrument records a pressure considerably less than static. In an aircraft which is many times as great as the static aerodynamic pressure and sometimes even greater. The pressure indicated by a barograph placed within a streamlined box and for various orientations of this opening are shown on the diagram, Fig. 2. These same results were made in one of the Cessna wind tunnels at Gardes City.

Rapid distances greater than the radius indicate pressure greater than actual static pressure, radial distances less than the radius correspond to pressures less than actual static pressure. On the diagram the pressure graph curves around at the points A and B and also at two points C and D in the rear. This means that if the aperture through which the pressure is communicated to the barograph were at any point as the circle at which A is the true, the indications should be correct. There is no such point, that is, would be away from the rear if the aperture were placed directly ahead but the rate change of pressure at these points on the circle is a maximum and large fluctuations are liable to occur and distort. Again there is another objection, in that the actual aperture of flow flow on a body, placed on a flying machine is hard to determine as shown by the difficulty of finding a suitable position for a wind-speed indicator.

Several years ago Dr. A. F. Zahm¹ proposed that the barograph case consist of a streamer body and that the barometer be hermetically sealed thereon except for a connection to an

¹There have been shown where the pressure aerodynamically on the side also was nearly zero and the static pressure correct. This corresponds to a suitable case of point D in altitude in 1934.

²Journal of the Franklin Institute, May, 1915, pp. 362.

aperture at a point of normal static pressure such as A. Fig. 3, taken from that paper, shows the pressure distribution around a streamer body. The barograph and connection to point A has been added to the drawing. It is to be noted that the connection could also be made to A'. The feasibility of pressure in this region, however, are very large and this position for the aperture has not been proposed. As far as this method of overcoming the difficulty is concerned, the writer

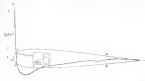


FIG. 3. DISTRIBUTION OF PRESSURE AROUND A STREAMER BODY

believes that if the barograph were connected to the static openings of a standard Pitot tube properly placed on the machine, the indications would be as reliable as the one just proposed. The main objection, however, to this method is that the proper position of the streamer body or static opening of the Pitot tube is infinitely and hard to find and when found might be a very inconvenient place. The argument to be developed below in this article contains all of these difficulties besides having other inherent important advantages.

A natural objection when these barometric errors are brought to the attention of anyone is that the barograph is usually placed in the fuselage and is, therefore, protected from the air stream and hence these objections do not apply. This

the outside air and rotating or oscillating the container so as to periodically cover the entire 360 deg. The rotations or oscillations are of rapid periods say one in five seconds. In an airplane at any constant altitude the barograph will register a graph similar to that shown in Fig. 4.

The figure where the two curves, taken from actual tests, correspond to measurements at two different air speeds it will be noticed that if the aperture is 45 deg. either side of the

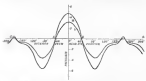


FIG. 4. GRAPH SHOWING VARIATION OF PRESSURE INDICATED BY A BAROGRAPH PLACED WITHIN A STREAMER AND MEASURED IN AN AIR STREAM FOR TWO DIFFERENT AIR SPEEDS

head-on position the observed pressure is normal or true static. At about 45 deg. the pressure has become negative by a amount greater than the pressure at location position.

The zero line of this graph is perfectly definite and can be found experimentally in any case. Even if fluctuations do occur the zero line is still definite because it is determined by the average of a large number of rotations of the barograph. If it is evident, since the pressure graph for any given instrument is to be defined by experiment, that the shape of the container is of no consequence so far as the method is concerned and, therefore, can be of the most convenient one, either aerodynamically or structurally, a short cylinder or a small sphere being found at present most convenient. It is

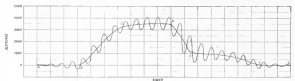


FIG. 5. INDICATIONS OF A BAROGRAPH OF THE NEW TYPE DURING A FLIGHT

proving is fallacious. There is an advantage to be derived from placing the instrument close inside of another one but this inside one must also be open to the air, the static pressure, of which we are measuring, and the pressure inside of this one depends, just as before, on the position of the opening. The pressure indicated by the barograph is static the opening at the opening of the outside air.

Now the barograph is not such a bar and as its opening is in air, it must, through the cockpit the pressure indicated is not so much, and is not reliable, but is subject to large variations due to the movement of the aircraft. A new form of barograph is proposed, one consisting of a small container, a small sphere, with an opening to

also evident, if the connection between the aperture and the barograph case is otherwise distorted, that the barograph may be placed outside in any convenient position on the machine, that is, on the instrument itself. The drawback which retains the recording mechanism of the barograph also retains the rotation of the case and the spring of this mechanism is kept wound up by a small, ground-based propeller of a few inches diameter.

Concluding, for simplicity, the exact variations of the pressure distribution around the instrument case, the record of a

³There is an error introduced by the rotation as shown by wind tunnel tests, even when they are so made as to avoid the error. This error is due to the principle in the case and not in the instrument itself.

11

back situated in the main structure of the ship. The air current also impinges in a special filter so arranged that caught off of the filter is exhausted in use while the other half is taken apart for cleaning purposes.

Wireless Equipment

The wireless equipment of the R 24 consists of a main transmitting set of 1,200 in. range, which is of the continuous type, an auxiliary continuous wave set, spark set, a wireless telegraph with a range of 100 m., and a wireless direction finder of 200 m. range. A 400-ft. leading aerial is used for all these sets except for the direction finder. The latter as well as all the rest of the wireless equipment functioned excellently and secured continuous communication with the Air Ministry in London throughout the cruise, while the 1,200 m. station read the small spark set at a distance of 200 m. despite the fact that it is only 1/10 of an electric horsepower.

Giant D. F. W. Biplane

The accompanying photographs illustrate one of the latest German giant machines, a D. F. W. biplane driven by four 60-hp. water-cooled engines of 200 hp. each.

All four engines are located in the fuselage and transmit their power to cranks of long lever gear shafts in four propellers.



Two of these are located in the upper plane, and are mounted below the upper plane, while the two others are mounted in the lower plane. The driving shafts for the fuselage engines run diagonally in up and out from the upper engines—the four engines being fitted in pairs on either side of the fuselage and in line of one another—while the shafts for the propeller engines extend horizontally from the lower engines. It even looks that the



propeller screws are not influenced by the ship screws of the fuselage, it will however be noted that the line of descent of the fuselage is well above the center of gravity, while that of the propellers is well below. What influence the simultaneous shutting off of either the fuselage or the propellers may exert



on the length of the shafts of the fuselage is a fair subject for speculation.

The two lower water-cooled engines in one division, and the propellers in the opposite.

The arrangement of the two-wheel landing gear is noteworthy as is the fuselage tail, with balanced elevators and rudders. The fuselage is apparently of monocoque construction, except the forward portion in which a considerable amount of metal seems to be used. No indication is at hand as to the ground clearance of the machine or as to its degree of success.

The manufacturer of the D. F. W. machine is the Deutsche Flugzeug Werke (German Airplane Works) of Leipzig, Germany.

Course in Aerodynamics and Airplane Design

Part III.—Experimental Aeronautical Engineering

By Alexander Klemin

Technical Editor, Aviation and Aeronautical Engineering, Consulting Engineer, Aerial Mail Service, Consulting Aeronautical Engineer
(Copyright, 1919, by Alexander Klemin)

Section 6. Instruments for Full Flight Testing—Continued

Standard Aneroid Barometer

Fig. 13 shows a standard aneroid barometer with the cover removed. The mechanism of the instrument is practically the same as that in the altimeter used in aeroplanes. The corrugated expansion chamber *B*, from which the air has been exhausted, expands or contracts with changes in atmospheric



FIG. 13. STANDARD TYPE OF ANEROID BAROMETER, WITH COVER REMOVED.

pressure, and is regulated by the leaf spring *A*. The leaf is mounted on pivots *J* and fitted with a compensator *R* to regulate, in some extent, the expansion of the upper and lower sections of the leaf spring *A*. As the expansion chamber *B*



FIG. 13. STANDARD TYPE OF ANEROID BAROMETER.

expands or contracts, its motion is transmitted through the spring *C* in the lever *F*, which is connected to the expense end of the leaf spring. This is connected to a system of small levers *K* and a very fine chain to the drum *L* on the spindle

of the collecting pointer *G*. An enclosed leaf spring *H* tends to move the pointer in the opposite direction to the chain, and thus keeps the chain under a very light tension all the time. This small chain occasionally may cause trouble by breaking or breaking when it winds on the drum *C*. A coil of chain in the chamber is connected under the pointer *G*. This coil may be marked to indicate atmospheric pressure, altitude, or to predict weather changes.

To indicate the altitude, it is placed in a metal pan which is connected to a mercury column gage. The pan has a heavy

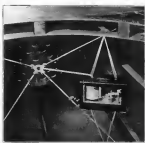


FIG. 13. STANDARD TYPE OF ANEROID BAROMETER.

glass receiver resting on a rubber gasket. The pressure is measured by regular intervals at a temperature of 10 deg. Cent., and simultaneous readings of the mercury gage are taken. This is continued until the given height of the instrument has been reached. The pressure is then measured until the ground pressure is reached.

The height corresponding to the observed height of the mercury is computed from the formula $H = 6700 \log \frac{P_0}{P}$ based on a temperature of 10 deg. Cent. To determine whether the instrument is affected by temperature, the above test is repeated at temperatures of -10 deg. Cent. and +40 deg. Cent.

Barograph

There is very little difference between the barograph and the aneroid—in fact, the barograph is merely a recording aneroid. Instead of the pointer and dial of the aneroid, there is a pen on the barograph which marks the altitude on a sheet wound around a drum. The drum is revolved by clockwork, and the pen draws an aerial curve of altitude against

The Air Service Parachute

In the month of experiments carried out at McCook Field, the Air Service has adopted a standard type of parachute for use from domestic airplanes which is considered superior to any other type, domestic or foreign.

The Air Service parachute is designed to carry a person weighing 200 lb. traveling at 300 m.p.h.; this requirement has experimentally been obtained by testing experimental parachutes carrying 400 lb. at 150 m.p.h. Specifications prescribe, for

the airplane to not recommend, but to ease the aviator desires this arrangement to save simply to a cord of the desired length into the rig and may make the airplane. Such a cord is not desirable. When the rip cord is pulled, among other things, hands come into play which pull the cords at the park apart and release the pilot chute, which springs open. The pilot chute then pulls the top of the main chute from the pack and holds it taut and straight until it fills with air. However, to ease the pilot chute fails to operate, the main chute would be blown out and spread, though not quite so rapidly.

With each chute is a sample of the fabric, cords, webbing, etc. This is marked with the serial number of the chute, as well as with the trade name, and should be tested at least monthly to determine its deterioration. In addition, it is thought that each month every chute on hand should be dropped, one test with a 300 lb. weight at 150 m.p.h. or the equivalent thereof.

In all the drops from airplanes so far carried out by the Air Service the engine has been throttled, and it is believed that the aviator can save minute when it will not be possible to clear the throttle as out the switch before jumping. In case the engine is falling the problem of getting away is not difficult or cannot be easily solved, and it is believed that, in matter of speed itself will be better than with reasonable limits. There will be ample time to get out of the engine under air, even when it is possible to get out of the engine, before a speed is reached which would cause failure of the chute. It will of course be necessary to clear all parts of the machine.

Further experiments are to be carried out with a view to determining the best method of escape from a plane in a case drive, opening more drive, etc. It is believed that this offers no considerable difficulty.

New York Landing Field

A proposal to establish permanent airplane landing fields in conjunction with the Federal Government has been presented to the Board of Estimate of New York City by Captain Leslie Craig, who declared that the establishment of such fields was worthy of serious attention.

"It is such a number of a few years before aerial interests, transportation, express service and service, emergency service and local photographic mapping, as well as aerial protection, will be a part of the activities of every city government," Comptroller Craig added. "Assurance is given that neither the Air Service nor the Post Office Department will deal with any private individual, society or corporation in the matter of landing fields."

The Comptroller's proposal was prompted by a memorandum that he received from Major Gen. Charles T. Menner, Director of Air Service, U. S. A., who said that since the city desired to cooperate with the Government in establishing landing fields, the Army will obligate itself to furnish engineers to be employed on the fields at the expense of the city.

The Army will also ask the city to bear the expense for establishing landing fields and the maintenance of both the fields and the equipment, exclusive of airplanes.

Loss of the C-8

The United States coastal seaplane C-8, Serial No. 2, Command, C. S. N., commanding, exploded for unknown reasons and was destroyed by fire on the afternoon of July 1, in a field near Long Island Sound, where she had been moored to enable trouble. A number of people were injured by the explosion.

The C-8 was under way at the time, which made an 8:00-m. cruise from Mitchell Naval air station to 80 miles N. E., and was subsequently torn from her moorings and blown out to sea. The 1-w was completed only recently, and on June 2 made a successful trip of 400 mi. from Albany, O., to Cape May, N. J., and returned. The C-8 was destroyed by fire on the afternoon of July 1, in a field near Long Island Sound, where she had been moored to enable trouble. A number of people were injured by the explosion.

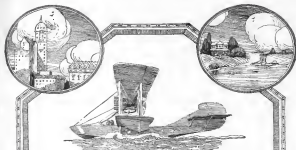


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even, that such service parachute shall be tested by dropping with 200 lb. at 150 m.p.h. so as not to strain the apparatus in the breaking limit.

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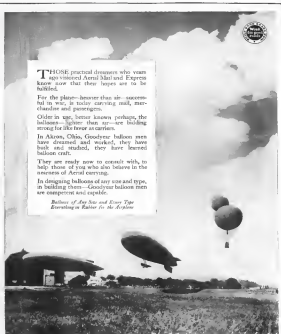
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